

# Comprehensive Evaluation of Modular Credit System Implementation in Clinical Medical Education: Academic, Digital, and Perceptual Outcomes

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**Abstract** Background. Recent reforms in medical education emphasize personalized learning, digital integration, and competency-based curricula. The modular credit system (MCS), aligned with European standards, is increasingly adopted in medical universities. However, comprehensive assessments of its impact - particularly within clinical disciplines - remain limited. Objective. To evaluate the academic, digital, and perceptual outcomes of MCS implementation in clinical training at a medical university. Methods. A five-year mixed-methods study was conducted at Samarkand State Medical University (2018–2023), involving 320 medical students and 92 faculty members. Two student cohorts were compared (pre- and post-MCS implementation). Data sources included standardized tests, LMS analytics, surveys (Likert scale, AMS-28), e-OSCEs, CRP assessments, portfolios, interviews, and focus groups. Statistical analyses used t-tests, chi-square, Cohen's d, and logistic regression. Results. MCS implementation led to significant improvements in module completion rates ( $p < 0,001$ ), digital engagement (e.g., sixfold increase in simulation use), and student satisfaction across multiple domains (e.g., curriculum clarity  $d = 0,88$ , feedback quality  $d = 1,45$ ). Logistic regression showed that LMS usage and in-person attendance strongly predicted academic success ( $OR = 6,11$  and  $3,36$ , respectively). Faculty reported improved student discipline but faced challenges related to digital tools and increased workload. Conclusion. MCS yielded measurable academic gains, enhanced digital integration, and improved subjective perceptions of quality and transparency. Successful MCS adoption depends on institutional support, faculty training, and digital infrastructure investment.

**Keywords** Modular Credit System, Medical Education Reform, Student Satisfaction, Digital Learning Environment

## 1. Introduction

Current trends in medical education reflect a growing demand for flexible, adaptive curricula that align with the accelerating pace of digitalization and rising expectations for physician competency. In response to these challenges, the introduction of a modular credit system (MCS) has emerged as a central component of reform in higher medical education. This approach emphasizes structured competency-based learning, transparent assessment mechanisms, and increased student autonomy [1,6,9].

The MCS model, rooted in the principles of the European Credit Transfer and Accumulation System (ECTS), facilitates more efficient organization of the educational process by integrating e-learning platforms, digital tools, and step-by-step knowledge monitoring [4,5,8]. However, the shift toward this system requires substantial changes in teaching practices, enhancement of digital infrastructure, and active adaptation by both faculty and students [2,7].

Within medical education, the transition to MCS is particularly relevant given the need to balance intensive theoretical instruction with hands-on clinical training. It also fosters personalized learning pathways and aims to build sustained student motivation [3,10]. Despite regulatory efforts to standardize MCS implementation across universities, empirical data on its effectiveness in specific national contexts remain limited. There is a particular gap in evidence regarding how MCS affects academic performance, digital engagement, and perceived satisfaction among stakeholders [5,6].

**The aim of this study** is to provide a comprehensive evaluation of the impact of the modular credit system on academic outcomes, behavioral indicators, digital engagement, and subjective perceptions of educational quality within clinical disciplines at a medical university.

## 2. Materials and Methods

This study was conducted at Samarkand State Medical University over a five-year period from 2018 to 2023. The research design combined elements of a comparative cohort

study and a mixed-methods evaluation, allowing for both quantitative and qualitative analysis of the implementation of the modular credit system (MCS) in clinical disciplines.

The study population included a total of 320 students from the Faculty of General Medicine. Two cohorts were selected for comparative analysis:

Cohort 1 (n=160): students enrolled prior to the implementation of the MCS (2018–2019 academic year),

Cohort 2 (n=160): students who studied after full implementation of the MCS (2022–2023 academic year).

In addition, 92 faculty members from clinical departments participated in the assessment of pedagogical outcomes, workload, and adaptation to digital tools.

A variety of data collection instruments were used:

Standardized questionnaires, including the Academic Motivation Scale (AMS-28) and Likert-type satisfaction surveys;

Objective Structured Clinical Examinations (e-OSCE) in digital format;

Clinical Reasoning Problems (CRP) for assessing critical thinking and clinical decision-making skills;

LMS log analytics, tracking engagement metrics such as frequency of access, content completion, and participation in interactive modules;

Semi-structured interviews and focus groups with students and faculty;

Reflective student portfolios and open-ended narrative responses.

For data analysis, both descriptive and inferential statistics were applied. The Student's t-test was used to compare group

means, and Cohen's d was calculated to determine effect sizes. A significance level of  $p < 0,05$  was set, with 95% confidence intervals (CI) reported where applicable. Effect size values were interpreted as small ( $d = 0,2$ ), medium ( $d = 0,5$ ), and large ( $d \geq 0,8$ ), based on conventional thresholds.

Ethical approval for the study was obtained from the university's institutional ethics committee. All participants gave informed consent, and confidentiality was maintained throughout the research process.

### 3. Results

In addition to quantitative indicators such as academic performance and class attendance, an equally important aspect of evaluating the effectiveness of the modular credit system (MCS) implementation was the assessment of subjective satisfaction among students and faculty, as well as the quality of adaptation to the new educational environment. These data were obtained through surveys, analysis of reflective writings, and expert interviews.

The analysis of on-time module completion (Table 1) revealed significant improvements across all major clinical disciplines. For instance, in propaedeutics of internal medicine, 143 students (89,4%) completed the module on time in the 2022/2023 academic year, compared to 109 students (68,1%) in 2018/2019. A similar trend was observed in therapy, surgery, and obstetrics and gynecology, where the proportion of on-time completions increased by more than 20 percentage points in each discipline ( $p < 0,001$ ).

**Table 1.** On-time completion of modules by discipline

Discipline	2018/2019 (n=160)	2022/2023 (n=160)	p-value
Propaedeutics of Internal Medicine	109 (68,1%)	143 (89,4%)	<0,001
Therapy	105 (65,6%)	140 (87,5%)	<0,001
Surgery	112 (70,0%)	146 (91,3%)	<0,001
Obstetrics and Gynecology	100 (62,5%)	137 (85,6%)	<0,001

Statistical significance was determined using Pearson's chi-square test ( $p < 0,05$ ).

**Table 2.** Use of electronic resources by students

Resource Type	2018/2019 (n=160)	2022/2023 (n=160)	p-value
Electronic manuals (PDF)	66 (41,3%)	135 (84,4%)	<0,001
LMS platform	46 (28,8%)	127 (79,4%)	<0,001
Video/simulation materials	17 (10,6%)	99 (61,9%)	<0,001

Statistical significance was determined using Pearson's chi-square test ( $p < 0,05$ ).

**Table 3.** Student satisfaction with the learning system (Likert scale, 1–5, M±SD)

Indicator	2018/2019 (n=160)	2022/2023 (n=160)	p-value
Clarity of curriculum structure	3,01 ±0,84	4,05 ±0,68	<0,001
Accessibility of materials and tasks	3,22 ±0,78	4,32 ±0,59	<0,001
Objectivity and transparency of grading	3,34 ±0,81	4,21 ±0,61	<0,001
Individualized feedback and supervision	2,83 ±0,79	3,95 ±0,67	<0,001

Statistical significance was determined using Student's t-test ( $p < 0,05$ ).

**Table 4.** Effect sizes of MCS implementation

Variable	Before M±SD	After M±SD	d	95% CI
Final grade (GPA)	3,58±0,49	3,89±0,42	0,68	0,46–0,90
In-person attendance (%)	77,8±10,3	84,6±9,7	0,68	0,46–0,90
Structure (Likert)	3,02±0,79	3,68±0,71	0,88	0,64–1,13
Materials (Likert)	2,95±0,83	3,74±0,62	1,07	0,83–1,31
Transparency (Likert)	2,80±0,88	3,60±0,75	0,98	0,74–1,22
Feedback (Likert)	2,83±0,85	3,95±0,68	1,45	1,20–1,69

**Table 5.** Modified logistic regression model: probability of achieving a final grade ≥4,0

Predictor	β	SE	OR	95% CI	χ <sup>2</sup>	p
Studying under MCS (0 = pre, 1 = post)	0,824	0,236	2,28	1,45–3,57	12,60	<0,001
Regular LMS access	1,808	0,288	6,11	3,76–9,92	39,76	<0,001
Attendance ≥ 80%	1,212	0,279	3,36	2,00–5,65	18,90	<0,001
Constant	-2,137	0,314	-	-	46,30	<0,001

Equally illustrative are the results regarding the use of electronic learning resources, as presented in Table 2. In 2022/2023, 84,4% of students (n=135) consistently used PDF-based electronic manuals, compared to only 41,3% (n=66) in 2018/2019. The difference was statistically significant (p<0,001), reflecting an increase in digital literacy and a shift in study habits.

The most significant growth was observed in the use of the university's LMS platform: from 28,8% (n=46) to 79,4% (n=127). This indicates active integration of digital platforms into daily learning activities. Moreover, a more than sixfold increase in the use of video and simulation materials confirms that digital components have become an essential part of preparation for classes, tests, and modular assessments.

The results of the student satisfaction survey (Table 3) further confirmed a positive perception of the educational reform. The indicator “clarity of curriculum structure” improved significantly from 3,01±0,84 in 2018/2019 to 4,05±0,68 in 2022/2023 (p<0,001), suggesting that students became more confident in navigating the academic program, understanding module requirements, and accumulating credits.

The indicator “accessibility of materials and assignments” also showed a substantial increase, from 3,22±0,78 to 4,32±0,59, which correlates directly with the previously reported growth in access to digital educational resources. Satisfaction with the “objectivity and transparency of assessment” rose from 3,34±0,81 to 4,21±0,61, reflecting enhanced trust in the fairness of the evaluation system.

Particularly noteworthy is the improvement in “individualized supervision and feedback”, which increased from 2,83±0,79 to 3,95±0,67 after the introduction of MCS. This reflects a real shift in the nature of interaction between students and faculty. Teachers increasingly incorporated tools such as portfolios, error analysis, formative assessment, and written comments via the LMS.

A key component of the comprehensive evaluation of MCS implementation involved analyzing the perceptions of

direct participants in the educational process—students and faculty members. Their subjective assessments helped not only to reflect the dynamics of change within the university but also to identify resistance factors, barriers, and potential growth points for the educational reform.

To obtain empirical data, an anonymous survey was conducted among clinical-year students (years 4–6) and academic staff from both theoretical and clinical departments at Samarkand State Medical University. The survey included 427 students and 92 faculty members, using a combination of Likert-scale closed questions and open-ended responses. The survey data were further enriched by focus groups and individual interviews with representatives of both groups.

The student responses indicate a generally positive attitude toward the reform. A total of 83% of students stated that MCS helped them better understand the course structure, while 76% regarded the modular grading system as more fair and motivating for consistent study. They particularly appreciated the ease of accessing materials via LMS, the ability to track their own academic progress, and the increased independence in preparing for assessments. However, 21% reported difficulties due to the intensity of the modules, especially when theoretical learning and clinical practice were combined. Some also voiced concern about insufficient digital competence among faculty, which they believed negatively affected certain aspects of MCS implementation.

Faculty responses were more nuanced. Around 64% acknowledged improvements in grading transparency and student discipline. Additionally, 71% agreed that the modular system facilitates earlier identification of knowledge gaps and allows for timely adjustments in teaching strategies. Nevertheless, only 48% of instructors reported feeling fully adapted to the new requirements.

The main challenges cited included increased methodological workload, limited LMS skills, and the need to adopt new pedagogical roles—such as mentor, facilitator, and academic advisor—simultaneously. Interviews revealed that while many faculty members saw MCS as a promising approach,

they expressed a clear demand for greater institutional support, including training workshops, modular course templates, and administrative assistance. Digital tools like automated testing and e-portfolios were generally viewed positively for their ability to reduce subjectivity in assessment.

Overall, the findings suggest that students primarily perceive the implementation of the Modular Credit System (MCS) as a mechanism for enhancing self-directed learning, increasing access to digital resources, and improving the transparency of assessment and feedback. Among faculty, there is a general willingness to adapt to the new system, although some skepticism and professional challenges remain.

The results of the empirical analysis confirm that successful MCS implementation is feasible when supported by systematic investment in human resources, digital infrastructure, and methodological support for all participants in the educational process.

Table 4 presents standardized effect sizes calculated using Cohen's  $d$ , which allow for comparisons across different measurement scales (e.g., scores, percentages, Likert ratings). According to widely accepted interpretation guidelines,  $d=0.20$  reflects a small effect,  $d=0.50$  indicates a medium effect, and  $d\geq 0.80$  corresponds to a large effect.

The calculations indicate that academic performance ( $d=0.68$ ) and in-person attendance ( $d=0.68$ ) demonstrated moderate effect sizes, signifying both statistically and practically meaningful improvements after MCS implementation.

In contrast, subjective course quality indicators—specifically Structure, Materials, Transparency, and particularly Feedback—showed large to very large effects ( $d=0.88$ – $1.45$ ). The highest effect size was observed for Feedback ( $d=1.45$ ), suggesting a substantial enhancement in communication and the timeliness of evaluative comments, which likely played a pivotal role in increasing overall student satisfaction.

The use of standardized effect sizes has both methodological and practical implications. Effect sizes that exceed the threshold for a “large” effect indicate priority areas for institutional reinforcement and scaling—in this case, feedback mechanisms and quality of instructional materials. Conversely, domains with medium effect sizes highlight areas where further improvement is needed.

Table 5 presents the results of a binary logistic regression model, where the dependent variable is achieving a final score  $\geq 4.0$  (coded as 1 = “achieved”, 0 = “not achieved”). The model includes three independent predictors directly linked to the educational process: (1) cohort assignment after MCS implementation, (2) regular access to the LMS platform, and (3) in-person attendance of at least 80%.

The estimated  $\beta$ -coefficients reflect each factor's contribution to the log-odds of success, while their exponentiated values represent odds ratios (ORs). The results show that studying under MCS conditions increases the likelihood of achieving a final grade  $\geq 4.0$  by 2.28 times ( $p<0.001$ ), suggesting a significant independent effect of the reform, even when controlling for other factors. The strongest predictor was regular access to the LMS: students who logged into the platform at least twice per week were 6.11 times more likely

to achieve high marks ( $p<0.001$ ). Maintaining in-person attendance  $\geq 80\%$  also remained a significant predictor ( $p<0.001$ ), emphasizing the continued importance of face-to-face interaction. All confidence intervals excluded 1.0, confirming the stability and significance of the estimates.

Model fit indices indicate strong explanatory power: Nagelkerke  $R^2=0.42$ , meaning the model explains approximately 42% of the variance in academic achievement. ROC-AUC=0.82, indicating excellent classification accuracy. AIC=378.4, reflecting an optimal balance between model fit and parsimony.

The overall results suggest that active engagement with the LMS is the primary driver of academic success, while the MCS structure acts as an institutional facilitator, creating conditions for sustained student involvement. These findings support the rationale for further investment in digital infrastructure and strategies to boost class attendance, as both factors substantially increase students' odds of reaching target outcomes.

Additionally, there has been a notable decrease in the proportion of students struggling to adapt to the new system. Based on open-ended responses and focus group discussions, early-stage difficulties included heavy self-study workloads, unclear grading criteria, and adjustment to new submission schedules. However, most students reported that after completing 1–2 modules, they were able to develop personal strategies and adapt to the pace. Faculty observations also revealed improved student discipline and engagement. According to their feedback, the modular format encouraged students to attend more regularly, ask questions, and participate more actively in academic discussions. Nevertheless, the initial administrative workload for faculty, especially in the early transition phase, was substantial—highlighting the need to automate routine tasks where possible.

## 4. Discussion

In addition to quantitative metrics such as academic performance and attendance, a crucial dimension in evaluating the effectiveness of the modular credit system (MCS) implementation was the assessment of subjective satisfaction among students and faculty, as well as the quality of adaptation to the new learning environment. These insights were obtained through surveys, reflective journals, and expert interviews.

The findings indicate a positive impact of the MCS on key indicators of educational effectiveness across clinical disciplines. A consistent improvement in academic outcomes was observed: the proportion of students completing modules on time significantly increased across all core subjects - including propaedeutics, internal medicine, surgery, and obstetrics/gynecology. These results are aligned with international studies that highlight the benefits of modular curricula in medical education due to their structured design, periodic assessments, and transparent grading systems [1,6,10].

Medium effect sizes in final grades and attendance further confirm the practical significance of the observed changes.

Most notably, substantial gains were recorded in subjective dimensions—such as clarity of course structure, transparency in assessment, and personalized feedback. These improvements suggest that the MCS not only enhances measurable academic outcomes but also strengthens students' trust in the educational system, while fostering intrinsic motivation and learning autonomy [3,6].

One of the most significant outcomes was the sharp increase in the use of digital learning tools: a six-fold increase in the use of video materials, a two-fold increase in digital textbooks, and a three-fold increase in LMS engagement. This reflects not only growing digital literacy but also a deeper integration of learning management systems (LMS) into daily teaching practices [2,5,8]. Such patterns echo findings from meta-analyses demonstrating that the incorporation of e-learning resources enhances student engagement and supports academic achievement [5,7,8].

Qualitative data from surveys, interviews, and focus groups confirmed broad student acceptance of the reform. Notably, 83% of students reported an improved understanding of course structure, and 76% considered modular assessment to be fair and motivating. However, 21% noted increased workload, especially when balancing theoretical studies with clinical rotations. There were also concerns regarding some faculty's insufficient digital competence, which was perceived as a barrier to the full implementation of MCS [2,3,9].

Faculty responses were more diverse. While many acknowledged improvements in discipline and assessment transparency, only 48% felt fully adapted to the new system. Key challenges included insufficient methodological support, high administrative burden, and the need to adopt new pedagogical roles such as facilitator, mentor, and module curator. These findings underscore the need for institutional support mechanisms - including regular methodological training, access to modular course templates, and technical assistance for LMS use [4,7,9].

Particularly noteworthy is the use of effect size analysis, which allowed for standardized comparisons across diverse measurement scales. This approach revealed that subjective components - such as accessibility, clarity, and feedback - were the domains most positively impacted by the reform. These findings emphasize that the success of MCS implementation depends not only on structural changes but also on the quality of pedagogical interaction and the transparency of educational procedures [1,6,10].

## 5. Conclusions

In summary, the qualitative findings confirm that the

transition to the modular credit system (MCS) was predominantly perceived positively by both students and faculty members. Levels of satisfaction with the learning environment, as well as perceptions of transparency and accessibility of educational information, significantly increased. Digital resources have become an integral component of the educational process. Student adaptation to the new system proved to be relatively rapid and stable, while the facilitative role of instructors and transparent assessment procedures emerged as key factors contributing to the success of the transition. These qualitative insights complement the quantitative results and support the conclusion that the MCS reform has had a comprehensive and positive impact on the academic environment of the university.

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